



Science at the petascale: Roadrunner results unveiled

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World's fastest supercomputer used to create first-of-a-kind computer codes and simulations of the biggest of the big and smallest of the small

Los Alamos, New Mexico, October 26, 2009—The world's fastest supercomputer, Roadrunner, at Los Alamos National Laboratory has completed its initial “shakedown” phase doing accelerated petascale computer modeling and simulations of a variety of unclassified, fundamental science projects. The Roadrunner system is now beginning its transition to classified computing to assure the safety, security, and reliability of the U.S. nuclear deterrent. Capitalizing on this national security investment, 10 unclassified projects were selected for this opportunity to use Roadrunner, a hybrid-architecture, 1.105 petaflop/s computing system, during a six-month period that ended in September 2009. These projects were also used to put a “work load” on

the Roadrunner system so that scientists could optimize the way large codes are able to run on the machine. The Roadrunner open science projects represent the best of science, and the value of enabling technologies at Los Alamos, and were selected from across the Laboratory by a special committee. A sampling of the projects include:

ORIGINS OF THE UNSEEN UNIVERSE Astrophysicists have created the largest-ever computer model of an expanding, accelerating universe to help scientists understand both dark matter and dark energy, two cosmic constituents that remain a mystery.

THE LARGEST HIV EVOLUTIONARY TREE Mapping Darwinian phylogenetic evolutionary relationships for large numbers of Human Immunodeficiency Virus genetic sequences results in an HIV family tree that may lead researchers to new vaccine focus areas.

NONLINEAR PHYSICS OF HIGH-POWERED LASERS Computer scientists adapt VPIC, a particle-in-cell plasma physics code, to simulate laser plasma interactions on the Roadrunner petascale supercomputer - models critical to understanding inertial confinement fusion at the National Ignition Facility.

MODELING TINY NANOWIRES AT LONG TIME-SCALE How nanowires break under stress is simulated atom-by-atom over a period of time that is closer than ever to experimental reality to see how the movement of single atoms can change a material's mechanical or electrical properties.

EXPLORING MAGNETIC RECONNECTION Magnetic reconnection is a basic process that occurs within hot ionized gases known as plasmas. This process often leads to an explosive release of energy that is stored within the magnetic fields, and plays a key role in the earth's magnetosphere, solar flares, magnetic fusion machines, and a variety of astrophysical problems.

HOW SHOCK WAVES CAUSE MATERIALS TO FAIL Physicists use SPaSM computer code to conduct multibillion-atom molecular dynamics simulations of materials as extreme shock-wave stresses break the materials into pieces, for the first time attempting to create atomic-scale models that describe how voids are created, how materials may swell or shrink under stress, and how a once-broken bond might reform.

About Roadrunner, the world's fastest supercomputer, first to break the petaflop barrier

On Memorial Day, May 26, 2008, the "Roadrunner" supercomputer exceeded a sustained speed of 1 petaflop/s, or 1 million billion calculations per second. "Petaflop/s" is computer jargon—peta signifying the number 1 followed by 15 zeros (sometimes called a quadrillion) and flop/s meaning "floating point operation per second." Shortly after that it was named the world's fastest supercomputer by the TOP500 organization at the June 2008 International Supercomputing Conference in Dresden, Germany.

The Roadrunner supercomputer, developed by IBM in partnership with the Laboratory and the National Nuclear Security Administration, will be used to perform advanced physics and predictive simulations in a classified mode to assure the safety, security, and reliability of the U.S. nuclear deterrent. The system will be used by scientists at the NNSA's Los Alamos, Sandia, and Lawrence Livermore national laboratories.

The secret to its record-breaking performance is a unique hybrid design. Each compute node in this cluster consists of two AMD Opteron™ dual-core processors plus four PowerXCell 8i™ processors used as computational accelerators. The accelerators used in Roadrunner are a special IBM-developed variant of the Cell processor used in the Sony PlayStation 3®. The node-attached Cell accelerators are what make Roadrunner different than typical clusters.

Roadrunner is still currently the world's fastest with a speed of 1.105 petaflop/s per second, according to the TOP500 announcement at the November 2008 Supercomputing Conference in Austin Texas, and it again retained the #1 position at the June ISC09 conference.

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